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GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: 4/14/78

Project Title: Program to Improve Jute Carpet Tufting

Project No: E-27-602

Project Director: Prof. W.C. Boteler

Sponsor: Jute Carpet Backing Council, Inc., New York, New York

Effective Termination Date: Open

Clearance of Accounting Charges: 3/31/78

Grant/Contract Closeout Actions Remaining: None

- _ Final Invoice and Closing Documents
- _ Final Fiscal Report
- _ Final Report of Inventions
- _ Govt. Property Inventory & Related Certificate
- _ Classified Material Certificate
- _ Other ______

Assigned to: Textile Engineering (School/Laboratory)

COPIES TO:

Project Director
Division Chief (EES)
School/Laboratory Director
Dean/Director—EES
Accounting Office
Procurement Office
Security Coordinator (OCA)✓
Reports Coordinator (OCA)
Library, Technical Reports Section
Office of Computing Services
Director, Physical Plant
EES Information Office
Project File (OCA)
Project Code (GTRI)
Other ______

CA-4 (3/76)

E-27-602

GEORGIA INSTITUTE OF TECHNOLOGY
A. FRENCH TEXTILE SCHOOL
ATLANTA, GEORGIA 30332

September 2, 1971

Jute Carpet Backing Council
c/o Mr. James McCowan
White Lamb Finlay, Inc.
The White Lamb Finlay Building
52 Upper Montclair Plaza
Upper Montclair, New Jersey 07043

Subject: Monthly Letter Report for July, 1971
Project No. E-27-602

Dear Sir:

Much of July was spent in working with Mr. Frank Ko on his study of the relationship between fabric construction and tuftability of jute carpet backing fabrics. Mr. Ko analyzed the data for all fabrics from A through T. In addition, he determined the fabric weights and yarn linear densities for the 34 fabrics. These data may vary somewhat from the IJIRA data, since the IJIRA yarn analysis was made on yarn from spinning bobbins. However, the IJIRA data were not made available to us. The yarn linear density data were made on yarns removed from the fabrics.

Several copies of Mr. Ko's thesis are enclosed for your information and file. The use of metric units makes the data difficult to compare with current data on jute fabrics, however, the essential information is being converted to "jute" language and a summary paper will be forwarded very shortly. For immediate convenience, a Xerox copy of Table I is included on which the fabric code has been added.

In general the results of Mr. Ko's analysis corroborate previous conclusions about the relationship between yarn linear density, weave factor, and crimp. The normalization of fabric strength to unit weight per unit area permits a better evaluation of the fiber efficiency in the tufted fabric than a straight weight comparison.

Approved:

James L. Taylor

Dr. James L. Taylor, Director
A. French Textile School

Respectfully submitted,

Winston C. Boteler

Winston C. Boteler
Project Director

WCB/dl

Enclosure

GEORGIA INSTITUTE OF TECHNOLOGY
A. FRENCH TEXTILE SCHOOL
ATLANTA, GEORGIA 30332

September 9, 1971

Jute Carpet Backing Council
c/o Mr. James McCowan
White, Lamb, Finlay, Inc.
The White Lamb Finlay Building
52 Upper Montclair Plaza
Upper Montclair, New Jersey 07043

Subject: Monthly Letter Report for August, 1971
Project E-27-602

Dear Sir:

1. On Friday, August 11, Dr. Radhakrishnan, Dr. Tolia and I visited Sweetwater Carpets and were guided through the plant by Mr. Art Thompson. All their carpets were shipped out for finishing; however, we were able to observe their dyeing operation. We then visited the Unique Finishing Company and were guided through by the foreman. Of major interest was the wetting out bath preceding the dryer. The fabric was merely passed under two rolls through a tank about 10 feet long and about 8 inches deep. The emerging fabric passed over a vacuum slot and then into the oven. For untufted fabric, a squeeze roll could give about the same regain. The foreman stated that detergents were added to permit good wetting and indicated that direct dyes had been added at times. This appeared to be a simple way to add a lubricating solution. We visited also Mr. A. N. Agrawal at Continental Textile Products Company. Mr. Agrawal showed us some filling stretch fabric and stated that there was a lot of interest in stretch fabrics for the automotive industry. This fabric was made by Ganges Mills and Dr. R. stated that other people were looking also at the automotive application of stretch fabrics. Saturday, August 12, was spent in discussion with Dr. R. at Georgia Tech. The quality ratio of the yarn in the fabric was discussed, as well as the requirement for a minimum breaking elongation of 5 to 6% to meet the requirements of the stenter frame. Numerous fabric calculations were made using a minimum grist of 7 pounds and the conclusion was reached that no fabric lighter than about 7½ oz./yd.^{2} would be practicable under the constraints required. There was considerable discussion about the initial modulus, and by comparison with data for spunbonded and woven poly fabrics, it was concluded that an initial modulus of about 1 to 1.5 lb./in./percent elongation should provide sufficient stability to make a good carpet. There was some discussion about fabric analysis. Dr. R. agreed to send the I.J.I.R.A. analyses on the experimental fabrics.

2. After Dr. R.'s visit, an analysis was made of the initial moduli of the pertinent tufted and untufted fabrics. The results are listed on the enclosed table and on Figures 208 and 208-1. There is a distinct drop in modulus for the lubricated fabrics compared to the control fabrics. The initial modulus involves

not only yarn crimp, but fiber freedom in the yarn, so that the lighter fabrics exhibit higher moduli. It is noted on the table and Figure 208 that P3, a lubricated 7 ounce fabric had the highest initial modulus of the lubricated fabrics. In addition, Figure 255 shows that the relationship between filling crimp and initial modulus for the lubricated fabrics is quite linear. The addition of face yarn causes an increase of 20-30% in the initial modulus. This is probably due to crimp interchange and increased inter-fiber friction. Figures 254 through 259 indicate that there is very good correlation between total fabric elongation, filling crimp and initial modulus. Figure 258 indicates that an untufted fabric with about 11% total filling elongation would have an initial modulus of about 1.2 lb./in. in the tufted state.

3. The quality ratio of the yarn in the fabric includes not only the quality ratio of the yarn but the efficiency of the yarn in the fabric structure. Grist values determined by Mr. Ko for the individual fabrics were multiplied by the actual ends and picks per inch to obtain the values of N_1 G_1 and N_2 G_2 plotted against breaking strengths in Figures 209 through 224. There are undoubtedly some reasonable errors in the determinations of yarn grist from small fabric samples. For comparison purposes, the quality ratio of 1.00 is shown as a dotted line on Figures 209 through 224. Figures 209 through 216 show the quality ratios in the fabric for tufted and untufted fabrics. Figures 209 and 210 indicate that the lubrication treatment did not reduce the quality ratio of the warpwise yarns, while Figure 211 shows some reduction in quality ratio due to the alkali treatment. A comparison of Figures 213 and 214 illustrates the very slight loss of strength in the warpwise yarns, with the heavier fabrics suffering somewhat great losses.

The good correlation shown on Figure 217 is probably an indication of the extra care taken in preparing the filling yarns. The decrease in quality ratio shown on Figure 218 may be due to the additional crimp added during shrinkage, as well as a reduction in fiber-to-fiber friction. Figure 221 illustrates in another way the effect of filling yarn breakage for the control fabrics. Here again, the P and T fabrics exhibit the best fiber efficiencies. The data spread is higher for the lubricated fabrics than for the alkali treated fabrics, which indicates the problem of treatment reproducibility with the lubricated fabrics.

4. To assist in predicting the success of the tufted fabrics on a stenter frame, an analysis was made of the entire sample population of fabrics broken on the Instron tester to determine the frequencies and relative cumulative frequencies of breaking elongations of the various fabric families. The warpwise frequency data are shown on Figures 225 through 230. Figures 225 through 227 show the results of crimp interchange, with a significant number of lubricated and stretch fabrics showing breaking elongations below 4%. The data for the tufted fabrics, Figures 228 through 230, show a significant number of breakages below 3%.

The fillingwise data, Figures 231 through 236, indicate that few breakages would be expected below 8% for the lubricated tufted fabrics (Figure 235) and none below 6%, which is about the maximum shrinkage to be expected on the stenter frame during drying.

The cumulative frequency data are shown on Figures 237 through 242. Figure 241 is of special interest, since it shows that only 1% of the tufted lubricated fabrics had filling breaking elongations of less than 6%, as compared to 60% of the tufted control fabrics.

To assist in the fabric design, some crimp and elongation data from selected fabrics were plotted. These data are shown on Figures 246 through 254. There is obviously a great deal of variation in the crimp, especially in the lubricated fabrics. In fact, the crimp vs. crimp data are not informative, except to illustrate the large fabric to fabric deviations. The correlations are slightly better for elongation vs. elongation data (Figures 251 through 254).

5. A letter from Mr. M. Kabir, of T.R.B., is enclosed. I will welcome your suggestions regarding an answer to the letter.

6. The cabinet mentioned in the new specifications for the Department of Transportation test can be made for less than $50.00 in materials. If the tests are going to be made, the cabinet can be made in our shop at very little expense. This would be your property and you could move it at some future date if so desired. We cannot make the test as specified at 30% R.H. without such a cabinet, so that if further experiments in flameproofing are envisioned, it would save time if the cabinet were made now.

7. Our data sheets are included for the M and N fabrics shipped recently from I.J.I.R.A. The M fabric was tufted at 10 stitches per inch, and while the strength retention was good at 58%, the breaking strength was low at 35 pounds/inch due to the low strength of the control fabric. The M fabric will be used for the mock dyeing and tentering tests for which preparations are underway. We do not plan to tuft the N fabric.

Respectfully submitted,

Winston C. Boteler

Winston C. Boteler
Project Director

Approved:

James L. Taylor

James L. Taylor, Director
A. French Textile School

E-27-602

GEORGIA INSTITUTE OF TECHNOLOGY
A. FRENCH TEXTILE SCHOOL
ATLANTA, GEORGIA 30332

November 16, 1971

Jute Carpet Backing Council
c/o Mr. James McCowan
White, Lamb, Finlay, Inc.
The White Lamb Finlay Building
52 Upper Montclair Plaza
Upper Montclair, New Jersey 07043

Subject: Monthly Letter Report for October, 1971
Project E-27-602

Dear Sir:

1. With regard to the "M" and "N" fabrics mentioned in the enclosed letter from IJIRA, dated October 5, we re-evaluated the two fabrics. We did find that their "N" fabric was in two pieces. The evaluations and comparisons are shown below.

IJIRA DATA		OUR DATA
"N" Fabric		
WT. oz./yd.^{2}	9.3	n = 7.7 n^1 = 8.2
Count	14.3 x 10.8	n = 13 x 10 n^1 = 13.5 x 10
F. Strength, lbs.	91	n = 60.7 lb. n^1 = 50.8 lb.
Width		= 38"
"M" Fabric		
"M" Fabric		7.6 oz./yd.^{2} 31" wide
Count		15 x 11
F. Strength		57.9

It is obvious that the two pieces of "N" fabric had different properties, although they appeared to be similar. We sent small samples of the fabric back to IJIRA as requested, but the tests indicated that the wrong fabric was sent to us.

2. With respect to Dr. R's comments on page 2 of the letter, we recognize the fact that the correlation coefficients will be different if n_1, G_1 and n_2, G_2 are the independent variables and the strength is the dependent variable, but the results of the plot will come out the same.

The comments regarding Figure 238 are correct and the values on the X-axis should be doubled on the figure in your file. The modified Typar and heat set woven polyethylene fabrics have initial moduli on the order of 3.5 lb./in./% elongation, therefore, we can not hope to equal these fabrics. Tufting evidently restricts the filling yarn movement by reducing the crimp and increasing the inter-fiber friction. The control fabric modulus is reduced after tufting because of the large number of broken filling yarns. I have not yet answered Dr. R's letter.

An analysis of the data for all tufted fabrics was made by the multiple linear regression method to establish the relationship between warp strength, filling strength, count, and grist for the untufted state fabrics. The following table gives the results from this analysis.

<u>WARPWISE</u>

1.) Control:

$$S_w = -31.7 + 1.40 \; N_1 G_1 - 0.088 \; N_2 G_2$$

MULTIPLE LINEAR REGRESSION COEFFICIENTS

$R_{n_2 G_2}, \; N_1 G_1, \; S_w = 0.19$

$R_{n_1 G_1}, \; N_2 G_2, \; S_w = 0.90$

$R_{S_w}, \; N_2 G_2, \; N_1 G_1 = 0.90$

2.) Lubricated:

$$S_w = 59.23 - 0.05 \; N_1 G_1 + 0.20 \; N_2 G_2$$

COEFFICIENTS

$R_{n_2 G_2}$, ..., ... = 0.74

$R_{n_1 G_1}$, ..., ... = 0.18

R_{S_w}, ..., ... = -.75

3.) Stretch:

$$S_w = -56.14 + 1.15\ N_1 G_1 + 0.28\ N_2 G_2$$

COEFFICIENTS

$R_{n_2 G_2}$, ..., ... = 0.66

$R_{n_1 G_1}$, ..., ... = 0.87

R_{S_w}, ..., ... = 0.89

FILLINGWISE

1.) Control:

$$S_f = 71.32 + 0.23\ N_1 G_1 + 1.47\ N_2 G_2$$

MULTIPLE LINEAR REGRESSION COEFFICIENTS

$R_{n_2 G_2}$, $N_1 G_1$, S_f = 0.93

$R_{n_1 G_1}$, $N_2 G_2$, S_f = 0.44

R_{S_f}, $N_2 G_2$, $N_1 G_1$ = 0.94

2.) Lubricated:

$$S_f = 94.47 - 0.455\ N_1 G_1 + 0.62\ N_2 G_2$$

COEFFICIENTS

R = 0.79

R = 0.68

R = 0.84

3.) Stretch:

$$S_f = 33.74 - 0.24\ N_1 G_1 + 0.62\ N_2 G_2$$

COEFFICIENTS

R = 0.94

R = 0.47

R = 0.94

The prediction equation was used to calculate the untufted filling strength of the "N" fabric sent by LJIRA. The calculated filling strength was 61.5 pounds per inch, while the actual filling strength was 57.9 lbs./in. It is believed that this type of equation can be very useful in predicting the breaking strength of tufting fabrics.

The mock dyeings are proceeding and should be completed during November. In addition, tests of both Monsanto and Virginia Chemical Company fire retardant compounds are underway.

Respectfully submitted,

Winston C. Boteler

Winston C. Boteler
Project Director

WCB/lmb

APPROVED:

James L. Taylor

James L. Taylor, Director
A. French Textile School

E-27-602

GEORGIA INSTITUTE OF TECHNOLOGY
A. FRENCH TEXTILE SCHOOL
ATLANTA, GEORGIA 30332

December 17, 1971

Jute Carpet Backing Council
C/O Mr. James McCowan
White, Lamb, Finlay, Inc.
The White Lamb Finlay Building
52 Upper Montclair Plaza
Upper Montclair, New Jersey 07043

SUBJECT: Monthly Letter Report for November, 1971

Dear Sir:

(1) The mock dyeing experiment was completed during the month. For this experiment, a 33 foot length of "M" fabric (13 x 10, 38 in. wide, 9.6 lb. filling grist) was tufted at 10 spi with 2600 denier nylon BCF yarn. The ends were sewn together to make a loop over the rotor of the laboratory dye beck. The fabric was rotated through about 75 gallons of water in the beck at 85 to 93° C for two hours, then run in cool water for about ten minutes while the bath was draining. A ten foot piece was cut from the carpet, extracted in a centrifugal dryer for 15 minutes, then set at the original width on a stationary tenter frame and allowed to dry overnight. The remaining 22 foot piece was kept wet until the following day, then extracted. An eleven foot length was tentered at 39 inches width and allowed to dry, while the remaining eleven foot piece was dried without tentering. This step was necessary since the tenter frame was only 11 feet long. During the second mock dyeing cycle, the 22 foot piece was processed through a time-temperature extraction tenter drying cycle identical to the first. Eleven feet of fabric remained and was kept wet, then processed through the dye bath a third time. Thus after the experiment three pieces of fabric were available which had been temperature cycled and tentered to the original width, one, two, and three times. The fabrics were conditioned for 24 hours, cut and evaluated by means of the Instron tester. The results are shown on the attached data sheets.

There appear to be no significant changes in breaking strength or elongation as a result of the repeated dyeing and tentering. There is a slight increase in the C. V. of filling breaking strength and a slight reduction in strength retention.

(2) An experiment was carried out with Virginia Chemical Company compound Vertex FRJ-1 to determine the effect on the tuftability of jute fabric. The original formula of 50% solids was diluted to 6.25% and 12.5% solids formulas. The compound was sprayed evenly on a jute fabric (15 x 13 - 8 oz/yd^2), using each formula, and allowed to dry overnight. The two fire retardant treated fabrics were then tufted at 10 spi with 2600 denier nylon BCF yarn. The fabrics were conditioned overnight and broken on the Instron tester. The results are shown on the accompanying data sheets. Compared to the average strength and elongation data obtained previously, it appears that the FRJ-1 causes no significant reduction in strength or elongation. There is very little color change after application of the FR compound.

(3) The Monsanto MCC-100/200/300 durable fire retardant system was evaluated by treating a piece of 8 oz - 15 x 13 fabric with the recommended formulation. The carpet formula consists of 4.8% of MCC-100, 6.7% of MCC-200, and 1.25% of MCC-300, along with 87.2% water by weight. A piece of fabric 13 inches wide and 5 yards long was padded through the solution twice and allowed to dry overnight at room temperature. The fabric was then cured for 4 minutes at 145-155° C in an oven. The fabric was conditioned for 24 hours, then tufted at 10 spi with 2600 denier BCF nylon. The fabric was evaluated for loss of strength and elongation. The results are shown on the accompanying data sheet. The strength loss resulting from the application of this FR system is unacceptable.

(4) Mr. Kim will leave on December 15 to enter the Ph.D. program in textiles at Clemson University. No replacement is contemplated at the present time.

Respectfully submitted,

Winston C. Boteler

Winston C. Boteler,
Project Director

WCB/lmb

APPROVED:

James L. Taylor

James L. Taylor
Director
A. French Textile School

DATA SHEET

BREAKING STRENGTH & ELONGATION OF ~~[illegible]~~ (TUFTED) FABRIC, (10 SPI MOCK-DYED, ONCE

Sample Number # M-10-① Stitches Per inch ____

Yarn Denier 2600 Teeth in Driving Gear ____ Weight ____ oz/yd^2

Specimen Number	Warpwise Breaking Strength (lbs.)	Warpwise Elongation Crimp	Warpwise Elongation Elong-ation	Warpwise Elongation TOTAL	Fillingwise Breaking Strength (lbs.)	Fillingwise Elongation Crimp	Fillingwise Elongation Elong-ation	Fillingwise Elongation TOTAL
1	60	6.0	3.7	9.7	37	7.5	8.3	15.8
2	63	6.2	3.7	9.9	38	11.4	7.9	19.3
3	65	5.1	4.2	9.3	37	8.8	7.5	16.3
4	62	5.2	3.6	8.8	50	9.2	8.4	17.6
5	73	-	-	-	26	7.8	6.9	14.7
6	70	4.6	3.7	8.3	32	9.3	7.8	17.1
7	60	4.2	3.6	7.8	47	10.2	7.1	17.3
8	60	4.5	5.2	9.7	59	11.2	10.9	22.1
9	55	4.3	3.1	7.4	48	9.7	8.7	18.4
10	62	-	-	-	29	9.3	10.3	19.6
11	63	4.3	4.9	9.2	28	8.3	8.3	16.6
12	62	4.6	4.2	8.8	42	9.2	8.9	18.1
13	71	4.3	4.0	8.3	40	11.1	9.1	20.2
14	65	-	-	-	38	10.5	8.9	19.4
15	68	4.6	4.3	8.9	68	12.6	10.7	23.3
16					36	10.7	7.4	18.1
17					59	9.5	10.9	20.4
18					39	9.1	8.9	18.0
19					34	10.7	8.6	19.3
20					29	10.2	7.5	17.7
21					56	11.2	11.7	22.9
22					55	10.5	13.5	24.0
23					31	5.6	5.9	11.5
24					51	5.5	7.6	13.1
25					59	6.5	8.7	15.2
26								
27								
28								
29								
30								
$\bar{X}$	63.9	4.8	4.0	8.8	42.7	9.4	8.8	18.2
σ	4.8	0.7	0.6	0.8	11.7	1.8	1.7	3.0
% CV	7.6	13.9	14.7	8.8	27.5	19.0	19.3	16.5
Maximum	73	6.2	5.2	9.9	68	12.6	13.5	24.0
Minimum	55	4.2	3.1	7.4	26	5.5	5.9	11.5
Range	18	2.0	2.1	2.5	42	7.1	7.6	12.5
Per cent Strength Retained	80.0 %	-	-	-	70.3 %	-	-	-

DATA SHEET

BREAKING STRENGTH & ELONGATION OF ~~[illegible]~~ (TUFTED) FABRIC, MOCK-DYED, TWICE, 10#

Sample Number # M-10-2 Stitches Per inch ______
Yarn Denier ______ Teeth in Driving Gear ______ Weight ______ oz/yd^2

Specimen Number	Warpwise Breaking Strength (lbs.)	Warpwise Elongation Crimp	Warpwise Elongation Elong-ation	Warpwise Elongation TOTAL	Fillingwise Breaking Strength (lbs.)	Fillingwise Elongation Crimp	Fillingwise Elongation Elong-ation	Fillingwise Elongation TOTAL
1	67	6.7	4.5	11.2	34	8.5	7.3	15.8
2	74	3.3	5.3	8.6	28	9.1	8.3	17.4
3	65	4.0	4.2	8.2	27	8.1	6.9	15.0
4	62	4.6	4.1	8.7	22	6.9	6.7	13.6
5	71	4.7	4.0	8.7	31	6.3	7.3	13.6
6	72	5.0	3.8	8.8	41	7.5	8.7	16.2
7	75	5.6	5.2	10.8	23	6.7	6.9	13.6
8	62	4.6	4.0	8.6	31	7.1	9.1	16.2
9	63	5.0	4.4	9.4	30	6.9	7.1	14.0
10	73	4.1	4.8	8.9	29	7.7	8.8	16.5
11	68	4.4	4.5	8.9	31	8.1	8.3	16.4
12	80	2.6	4.6	7.2	23	8.0	6.5	14.5
13	85	2.7	4.8	7.5	38	8.5	9.3	17.8
14	78	4.0	5.6	9.6	49	8.7	11.4	20.1
15	80	3.8	5.0	8.8	44	9.2	10.9	20.1
16					63	10.9	15.5	26.4
17					54	10.6	13.8	24.4
18					35	8.7	8.9	17.6
19					31	8.4	9.6	18.0
20					44	10.1	12.2	22.3
21					55	11.3	14.0	25.3
22					52	10.7	14.2	24.9
23					27	8.7	8.7	17.4
24					37	8.9	9.8	18.7
25					31	9.3	9.9	19.2
26								
27								
28								
29								
30								
$\bar{X}$	71.7	4.3	4.6	8.9	36.4	8.6	9.6	18.2
σ	7.2	1.1	0.5	1.0	11.1	1.4	2.6	3.8
% CV	10.0	24.4	11.5	11.7	30.6	15.8	26.9	21.1
Maximum	85	6.7	5.6	11.2	63	11.3	15.5	26.4
Minimum	62	2.6	3.8	7.2	22	6.3	6.5	13.6
Range	23	4.1	1.8	4.0	41	5.0	9.0	12.8
Per cent Strength Retained	89.7 %	–	–	–	60.0 %	–	–	–

DATA SHEET

BREAKING STRENGTH & ELONGATION OF ~~JUTE~~ (TUFTED) FABRIC, 10 SPI. THRICE MOCK-DYED,

Sample Number # M-10-3 Stitches Per inch ____________

Yarn Denier 2600 D Teeth in Driving Gear ________ Weight ________ oz/yd^2

Specimen Number	Warpwise				Fillingwise			
	Breaking Strength (lbs.)	Elongation			Breaking Strength (lbs.)	Elongation		
		Crimp	Elongation	TOTAL		Crimp	Elongation	TOTAL
1	75	4.7	3.6	8.3	23	8.7	5.2	13.9
2	69	4.8	4.0	8.8	39	9.7	6.7	16.4
3	61	4.5	4.8	9.3	32	11.7	6.0	17.7
4	63	4.0	4.2	8.2	30	10.7	5.5	16.2
5	73	3.3	3.6	6.9	36	10.7	6.4	17.1
6	68	4.5	3.6	8.1	20	7.7	5.9	13.6
7	66	5.0	2.9	7.9	26	9.9	5.4	15.3
8	66	4.9	4.6	9.5	32	9.6	5.5	15.1
9	74	5.4	5.4	10.8	35	11.4	5.6	17.0
10	59	5.4	4.9	10.3	49	11.1	9.9	21.0
11	57	4.1	4.9	9.0	61	14.5	10.2	24.7
12	79	5.0	3.4	8.4	26	9.7	5.4	15.1
13	65	5.1	3.1	8.2	18	7.0	5.5	12.5
14	79	3.7	3.2	6.9	26	8.7	5.2	13.9
15	56	3.8	3.4	7.2	37	10.4	6.5	16.9
16					57	12.3	9.0	21.3
17					52	11.1	7.3	18.4
18					55	13.5	8.3	21.8
19					36	13.1	8.0	21.1
20					34	12.1	8.0	20.1
21					25	9.5	6.4	15.9
22					42	11.6	6.1	17.7
23					58	12.9	8.0	20.9
24					61	12.8	8.4	21.2
25					55	12.5	7.2	19.7
26								
27								
28								
29								
30								
$\bar{X}$	67.3	4.5	4.0	8.5	38.6	10.9	6.9	17.8
σ	7.5	0.6	0.8	1.1	13.6	1.9	1.5	3.1
% CV	11.1	14.1	19.6	13.3	35.2	17.0	21.7	17.6
Maximum	79	5.4	5.4	10.8	61	14.5	10.2	24.7
Minimum	56	3.3	2.9	6.9	18	7.0	5.2	12.5
Range	23	2.1	2.5	3.9	43	7.5	5.0	12.2
Per cent Strength Retained	84.2 %	-	-	-	63.6 %	-	-	-

VIRTEX FRJ-1

JUTE

FLAME RETARDANT

DESCRIPTION:

VIRTEX FRJ-1 is a water-soluble, flame retardant, specifically designed for jute. FRJ-1 is supplied as an aqueous solution containing 50% solids.

APPLICATION:

FRJ-1 should be applied by spraying. A solid add-on of 5 to 15% is recommended. At the lower addition levels (5-7%), FRJ-1 retards burning. At higher levels (13-15%), the fibers become self-extinguishing.

BENEFITS:

1. The hand of the jute is not affected by treatment with FRJ-1.
2. FRJ-1 is compatible with oil and latex emulsions.
3. Jute treated with FRJ-1 passes test outlined by MVSS-302.
4. The use of oil can be eliminated since FRJ-1 controls dust and fly.

PROPERTIES:

Color	Clear
pH Range	7.5 - 8.0
Salting Point	-23°C. (-9°F.)
Pounds per Gallon @ 25°C.	9.76
Viscosity, CPS	10 - 15
Wt. % Solids	50

CONTAINERS:

VIRTEX FRJ-1 is available in 55 gallon polyethylene-lined, fiber drums containing a net weight of 500 pounds. FRJ-1 is also available in tank trucks.

HANDLING CONDITIONS:

As in the case of all new products, care should be exercised in handling FRJ-1. There are no known toxic effects; however, no warranty can be offered concerning the use and toxicological properties of the product. In case of skin contact, flush the area thoroughly with water.

TECHNICAL SERVICE:

Virginia Chemicals Inc. manufactures other flame retardants for natural fibers and has the facilities and technical capabilities to develop formulations for special applications. For further information contact the Industrial Chemical Department. (Telephone 703 484-5000).

Price range 24 to 28¢/lb based on quantities.

Virginia Chemicals Inc., Portsmouth, Virginia 23703

DATA SHEET

BREAKING STRENGTH OF TUFTED FABRIC, FIRE-RETARDANT TREATED BY SPRAYING, 15x13 B FABRIC (JUTE) 6.25% SOLID-ADD-ON. (VIRGINIA)

Sample Number # 6.25% SOLID   Stitches Per Inch 10.2 SPI

Yarn Denier 2600 D   Teeth in Driving Gear

Specimen Number	Warpwise				Fillingwise			
	Breaking Strength (lbs.)	Crimp %	Elong. %	Total %	Breaking Strength (lbs.)	Crimp %	Elong. %	Total %
1	93	5.3	4.9	10.2	31	1.7	5.0	6.7
2	107	5.6	5.3	10.9	16	1.8	3.0	4.8
3	76	5.3	3.9	9.2	13	1.4	3.0	4.4
4	88	5.1	4.5	9.6	18	1.6	4.0	5.6
5	97	5.2	5.3	10.5	24	1.3	5.4	6.7
6	101	4.8	6.4	11.2	29	2.6	2.9	5.5
7	101	4.9	5.0	9.9	31	1.4	4.8	6.2
8	90	5.8	4.5	10.3	18	1.0	4.1	5.1
9	101	5.1	4.6	9.7	38	2.6	4.2	6.8
10	97	4.9	4.6	9.5	39	2.5	4.8	7.3
11					26	1.5	4.3	5.8
12					29	1.6	4.4	6.0
13					27	1.6	4.0	5.6
14					33	1.9	3.9	5.8
15					20	1.5	2.9	4.4
16					24	2.0	3.6	5.6
17					30	2.6	3.9	6.5
18					28	1.8	3.8	5.6
19					21	1.7	4.0	5.7
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
Average, $\bar{y}$	95.1	5.2	4.9	10.1	26.1	1.8	4.0	5.8
Standard Deviation, σ	8.8	0.3	0.7	0.6	7.1	0.5	0.7	0.8
Coefficient of Variation, $\sigma / \bar{y} \times 100$ %	9.3	6.1	13.7	6.3	27.4	26.2	17.9	13.6
Maximum	107	5.8	6.4	11.2	39	2.6	5.4	7.3
Minimum	76	4.8	3.9	9.2	13	1.0	2.9	4.4
Range	31	1.0	2.5	2.0	26	1.6	2.5	2.9
Per Cent Strength Retained	76.7 %	-	-	-	29.0 %	-	-	-

Bates: B Fabric 10.3 SPI 2600 D.

83%   41%

(VIRGINIA)

DATA SHEET

BREAKING STRENGTH OF TUFTED FABRIC, (15X13, B FABRIC, 12.5% SOLID ADD-ON FIRE-RETARDANT TREATED BY SPRAYING)

Sample Number # 12.5% SOLID Stitches Per Inch 10.4 SPI

Yarn Denier 2600 D. Teeth in Driving Gear

Specimen Number	Warpwise				Fillingwise			
	Breaking Strength (lbs.)	CRIMP %	ELONG. %	TOTAL %	Breaking Strength (lbs.)	CRIMP %	ELONG. %	TOTAL %
1	90	5.3	5.7	11.0	23	0.9	4.6	5.5
2	96	5.2	5.6	10.8	36	1.5	4.3	5.8
3	81	4.8	4.7	9.5	23	1.1	3.7	4.8
4	91	6.1	7.7	13.8	18	0.9	3.3	4.2
5	87	6.5	5.9	12.4	23	0.9	4.4	5.3
6	86	5.5	8.8	14.3	31	0.8	3.6	4.4
7	80	6.1	6.9	13.0	22	0.9	2.9	3.8
8	96	5.1	8.0	13.1	36	1.5	3.7	5.2
9	90	4.9	10.2	15.1	39	1.8	4.4	6.2
10	96	5.5	6.9	12.4	40	1.7	4.2	5.9
11					16	1.3	3.1	4.4
12					20	1.1	3.7	4.8
13					22	1.4	3.3	4.7
14					26	1.4	3.9	5.3
15					35	1.3	4.2	5.5
16					28	1.5	3.1	4.6
17					25	1.3	3.7	5.0
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
Average, $\bar{y}$	89.3	5.5	7.0	12.5	27.2	1.3	3.8	5.0
Standard Deviation, σ	5.9	0.6	1.7	1.7	7.5	0.3	0.5	0.6
Coefficient of Variation, $\sigma/\bar{y} \times 100$ %	6.6	10.2	23.7	13.7	27.7	24.3	13.7	12.9
Maximum	96	6.5	10.2	15.1	40	1.8	4.6	6.2
Minimum	80	4.8	4.7	9.5	16	0.8	2.9	3.8
Range	16	1.7	5.5	5.6	24	1.0	1.7	2.4
Per Cent Strength Retained	72.0%	–	–	–	30.2%	–	–	–

Bates : B fabric, 10.3 SPI, 2600 D.

83 % 41 %

DATA SHEET

BREAKING STRENGTH & ELONGATION OF ~~JUTE~~ (TUFTED) FABRIC, ON "B" FABRIC (JUTE)

Sample Number # FIRE-RETARDANT TREATED (MONSANTO) Stitches Per inch 10.1 SPI
Yarn Denier 2600 D Teeth in Driving Gear ______ Weight ______ oz/yd^2

Specimen Number	Warpwise Breaking Strength (lbs.)	Warpwise Elongation Crimp	Warpwise Elongation Elong-ation	Warpwise Elongation TOTAL	Fillingwise Breaking Strength (lbs.)	Fillingwise Elongation Crimp	Fillingwise Elongation Elong-ation	Fillingwise Elongation TOTAL
1	45	4.7	4.8	9.5	8	–	6.0	–
2	59	3.8	3.1	6.9	11	0.9	4.1	5.0
3	54	4.7	3.7	8.4	12	0.5	2.7	3.2
4	30	3.2	5.6	8.6	14	0.4	5.2	5.6
5	54	4.0	5.6	9.6	14	–	8.3	–
6	54	4.3	4.2	8.5	10	–	6.1	–
7	56	3.7	3.8	7.5	6	–	5.2	–
8	65	4.0	4.8	8.8	10	0.5	4.6	5.1
9	64	3.8	4.2	8.0	7	–	5.3	–
10	57	3.8	4.0	7.8	10	0.8	5.5	6.3
11					11	0.3	9.9	10.2
12					17	0.8	3.6	4.4
13					13	0.7	3.4	4.1
14					19	0.3	7.3	7.6
15					7	0.5	5.4	5.9
16					15	0.5	5.0	5.5
17					17	2.0	3.0	5.0
18					14	1.0	3.6	4.6
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
$\bar{X}$	53.8	4.0	4.4	8.4	11.9	0.7	5.2	5.6
σ	10.1	0.5	0.8	0.8	3.7	0.4	1.9	1.8
% CV	18.7	11.5	18.6	10.1	31.3	63.3	35.5	31.6
Maximum	65	4.7	5.6	9.6	19	2.0	9.9	10.2
Minimum	30	3.2	3.1	6.9	6	0.3	2.7	3.2
Range	35	1.5	2.5	2.7	13	1.7	7.2	7.0
Per cent Strength Retained	43.4 %	–	–	–	13.2 %	–	–	–